THE AQUACULTURE SITUATION IN THE MEDITERRANEAN SEA PREDICTIONS FOR THE FUTURE

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INTRODUCTION

Marine living resources provide an important and increasing source of protein in many countries; one third of the total world supply comes from aquaculture activities. As in many parts of the world, aquaculture production in the Mediterranean has been expanding rapidly over recent years. Thus in the Mediterranean and Black Sea, although captures have stabilized and conventional species fully exploited, over-exploited, depleted or in the process of rebuilding strength, the share of aquaculture out of the total fisheries production has grown from 4% in 1980 to about 13% in 2000. Moreover for some species, such as mussels, clams, oysters, seabream, seabass, trout, tilapias, and carps, the majority of the production comes almost entirely from aquaculture.

Total aquaculture production in the region reached 1 349 777 tonnes in 2001, which represented approximately 3% of the world aquaculture production (48 413 635 tonnes). Although Mediterranean aquaculture used to focus more on mollusc production (62% in 1992), the share of fish production is constantly increasing (from 37% in 1992 to 53% in 2001), as it is happening on a worldwide level.

BRIEF HISTORY OF MEDITERRANEAN AQUACULTURE

Aquaculture in the Mediterranean region is an activity which started many centuries ago. It is possible to find records of aquaculture activities during the ancient Egyptian civilization. The tomb of Aktihep (2500 BC) shows what appears to be men removing tilapia from a fish pond. In the Etruscan culture (Italy) the earliest extensive marine farms date back to the 6th century BC. Growing of molluscan shellfish was practised in the 5th century BC by the Greeks. In the ancient Roman civilization seabass, seabream, mullets and oysters were cultivated or simply kept alive off the Italian coast in enclosed facilities.

The end of the Roman Empire led to the disappearance of this type of aquaculture, and it was not until the 12th century AD that a resurgence of freshwater aquaculture was seen, starting in central Europe. It was only in the 15th century AD that extensive, large-scale aquaculture was seen in the lagoons of the northern Adriatic, referred today as 'vallicultura'. These activities were somewhat promoted as a result of the religious practice of prohibiting the consumption of meat on Fridays. Thereafter, in the 19th century AD, the culture of shellfish once again became common practice, particularly in the Western Mediterranean and along the northern shores of the Adriatic Sea.

This origin strongly conditioned the beginning of the modern marine Mediterranean aquaculture, which effectively started about 25 years ago. Most Mediterranean countries are involved in this growth. It is highlighted that this new form of aquaculture has developed as a result of significant research mainly in the fields of reproduction, larval culture, feed manufacturing and engineering technology, among other specialities. As regards to species, recent aquaculture developments focus on the popular carnivorous finfish species with either a low production volume from capture fisheries or from over-fishing stocks. The technology applied has evolved rapidly as a result of the modifications of existing farming facilities (e.g. water recirculation for land based installations) and the development of new farming concepts (e.g. off-shore submerged netcage technology). As a consequence of such developments, nowadays, in the Mediterranean a wide-range of production activities of marine species co-exist in different environments using a variety of production technologies; from extensive mollusc or fish production to highly intensive raceways or netcage fish farming.

MEDITERRANEAN AQUACULTURE: CURRENT PRODUCTION STATUS

The statistics presented are those from the FAO FishStat databases covering aquaculture production in all GFCM (General Fisheries Commission for the Mediterranean) member countries. The production figures include freshwater aquaculture production, French and Spanish production from the Atlantic coast, as well as that of the Red Sea in Egypt. The reason for including these statistics is due to the mere difficulty in differentiating outputs from separate geographical areas (or seas). However, it should be note that most of the production ends up anyway in local domestic markets. For the purpose of this paper the aquaculture statistics of Japan (a GFCM member country) have not been considered.

Mediterranean aquaculture production has grown steadily over the years. Looking closely at the annual growth rate it can be observed that total aquaculture production in the region totalled approximately 1 350 000 tonnes in 2001 (Table 1), which represented an increase of 81.8% from 1992 to 2001 and an annual growth rate of 7.1% during this period.

Although Mediterranean aquaculture used to focus more on mollusc production (62% in 1992), the share of fish production is progressing constantly (from 37% in 1992 to 53% in 2001), similarly to the world aquaculture trend.

Table 1. Aquaculture Production in the Main Species Groups in the Mediterranean (tonnes).

	1992	1995	1998	2001	Growth '92-'01	Annual Growth Rate
Molluscs	461 828	566 595	633 560	626 080	35,6	3,7
Freshwater fishes	122 700	104 406	156 297	293 449	139,2	12,0
Marine fishes	33 701	68 408	136 835	253 137	651,1	25,7
Diadromous fishes	119 045	146 746	171 306	173 812	46,0	4,4
Aquatic plants	5 052	5 100	3 060	3 013	-40,4	-4,5
Crustaceans	240	273	560	286	19,2	8,9
Total	**742 566**	**891 528**	**1 101 618**	**1 349 777**	**81,8**	**7,1**

(Source: FAO, FIDI, 2003)

The species group that has shown the fastest growth rate has been the marine finfish (seabream, seabass, mullets, etc.) increasing from 33 701 tonnes in 1992 to 253 137 tonnes in 2001, corresponding to an annual growth rate of 25.7% over this period. Freshwater fish (mainly tilapias and carps) also experienced a significant growth rate over this same period (from 122 700 tonnes to 293 449 tonnes, corresponding to a 12% annual growth). Diadromous fish species (trouts at the top of the list), however, had an annual increase of only 4.4% during the same period (from 119 045 tonnes in 1992 to 173 812 tonnes in 2001).

Besides finfish, the overall mollusc production has developed less significantly with an annual growth of 3.7% moving from 461 828 tonnes in 1992 to 626,080 tonnes in 2001. Mussels, oysters and clams represent the main productions. The output of crustaceans and seaweeds is still limited. *Gracilaria* is the main species of seaweed cultured in the region with over 3 000 tonnes harvested in 2001. With regards to crustaceans the 2001 production of various shrimp species and the Red swamp crawfish (*Procambarus clarkii*), amounted only to 260 and 26 tonnes, respectively.

In the Mediterranean countries aquaculture production is dominated by six countries: Egypt, Spain, France, Italy, Greece and Turkey (Table 2), which jointly supply 96% of the total production in the region. Whilst in Spain, France and Italy the production is mainly based on molluscs (mussels, oysters, and clams), in Egypt the production is based on the semi-intensive production of freshwater (mainly tilapia and carp) and marine finfish species (mullet). Greece and Turkey, among others, concentrate mainly on the intensive production of selected finfish (seabream, seabass and trout). The average growth rate in these countries over the last decade has been impressive, with 24.6% in Egypt, 26.4% in Turkey and 20% in Greece. The increasing production from countries such as Malta, Cyprus and Israel (mainly finfish) should also be pointed out. On the other hand the statistics show that there are countries where aquaculture output has decreased (Algeria and Romania), and others that have contributed minimum quantities such as Albania, Algeria, Lebanon and Libya.

Species commodities and diversification

Aquaculture production not only accounts for an increasing share of the total supply in volume, but also in the offer of farmed species. The increasing diversification may certainly facilitate the growth of the sector. In the evolution of the number of cultured species in the latest two decades in the Mediterranean aquaculture sector, there has been a clear tendency towards diversification. In 2001, FAO statistics showed a production data for 85 species, out of which 51 produced over 100 tonnes. In the same year, FAO statistics recorded 427 different captured species for the Mediterranean and Black Sea (253 species with captures over 1 000 tonnes). Significant aquaculture production (over 100 tonnes) is recorded for 40 finfish species and 11 mollusc species (Table 3).

Table 2. Aquaculture Production Growth of the Main Species Groups in the Mediterranean Countries (tonnes).

Country	Molluscs	Diadromous fishes	Marine fishes	Freshwater fishes	Crustacean	Aquatic plants	Total	Increase '92-'01	Annual Growth Rate
Egypt	-	1	98 890	243 964	9	-	342 864	436,6	24,6
Spain	256 403	36 186	19 929	13	116	-	312 647	85,3	8,8
France	191 330	44 866	5 111	10 692	53	10	252 062	0,7	0,2
Italy	149 000	47 200	20 700	1 350	19	3 000	221 269	29,9	3,3
Greece	25 970	3 252	68 082	498	-	-	97 802	381,6	20,5
Turkey	5	38 064	28 485	687	-	-	67 241	640,1	26,4
Israel	-	940	4 530	14 630	-	-	20 100	64,6	5,8
Romania	-	600	-	10 218	-	-	10 818	-56,1	-7,9
Croatia	3 000	1 261	2 500	3 405	-	-	10 166	49,5	9,3
Syria	-	-	-	5 880	-	-	5 880	14,9	2,9
Cyprus		83	1 725	-	75	-	1 883	1 114,8	34,1
Tunisia	46	11	1 304	507	-	-	1 868	117,5	13,3
Bulgaria	-	893	-	717	-	3	1 613	-80,2	-8,9
Morocco	156	120	506	580	-	-	1 362	83,8	11,0
Malta	-	-	1 235	-	-	-	1 235	147,0	14,0
Lebanon	-	300	-	-	-	-	300	130,8	13,2
Albania	150	15	100	7	14	-	286	-28,0	9,0
Algeria	20	20	40	201	-	-	281	91,2	11,6
Libya	-	-	-	100	-	-	100	25,0	2,6
Total	**626 080**	**173 812**	**253 137**	**293 449**	**286**	**3 013**	**1 349 777**	**81,8**	**7,1**

(Source: FAO, FIDI, 2003)

Table 3. Mediterranean Aquaculture Species Diversification.

Production (tonnes)	No. of cultured species				
Fish	1981	1986	1991	1996	2001
> 50 000	2	2	2	1	5
50 000 - 10 000	-	2	2	6	5
10 000 - 1 000	9	8	14	13	11
1 000 – 100	7	11	12	11	19
Total fish > 100	18	23	30	31	40
Mollusc					
> 50 000	3	3	3	3	4
50 000 - 10 000	1	1	1	1	-
10 000 - 1 000	-	2	4	4	4
1 000 – 100	-	1	1	3	3
Total mollusc > 100	4	7	9	11	11
Total species > 100	**22**	**30**	**39**	**42**	**51**

(Source: FAO, FIDI, 2003)

With regard to molluscan shellfish the production is represented mainly by four species (*Mytilus edulis*, *Mytilus galloprovincialis*, *Crassostrea gigas*, and *Ruditapes philippinarum*) concentrated in three EU countries: mussels in Spain (over 250 000 tonnes), oysters in France (over 135 000 tonnes) and clams in Italy (over 50 000 tonnes). The contribution of other Mediterranean countries is still very low. Whilst mussel production relies on two autochthonous species (*M. edulis* and *M. galloprovincialis*), oyster and clam culture are sustained by two recently introduced allochthonous species *(C. gigas* and *R. philippinarum*). Other mollusc species have a less significant production, e.g. common edible cockle (*Cerastoderma edule*) with 2 968 tonnes and the Great Atlantic scallop (*Pecten maximus*) with 140 tonnes.

Fish production (above 10 000 tonnes) is mainly represented by about ten species (tilapias, carps, trout, seabream, seabass, and mullets). Other important species are the European eel, turbot, bluefin tuna, and other freshwater species, such as European perch, pike-perch, sturgeon, and tench.

In the finfish group, it should be noted that although marine finfish species is the group with the highest growth rate, the top-two ranking species in terms of production are freshwater fish, i.e. the Nile tilapia (*Oreochromis niloticus*) with over 150 000 tonnes and the Rainbow trout (*Oncorhynchus mykiss*) with over 120 000 tonnes. Most tilapia cultivation is based on extensive and semi-intensive farming systems in Egypt. Trout is mostly produced in freshwater and takes place in intensive systems using concrete raceways or ponds in Italy, France, Spain and Turkey.

The rapid increase in the production of marine carnivorous fish, particularly the Gilthead seabream (*Sparus aurata*) and the European seabass (*Dicentrarchus labrax*) is most evident, with over 80 000 tonnes in 2001 in the case of the first species and almost 60 000 tonnes for the seabass. The rapid output growth for these two species and now also for the European turbot (*Psetta maxima*) has resulted from the development of reliable seed production techniques, the formulation of specialized feeds and the application of intensive production systems, particularly cages. Furthermore, the support from the EU and strong markets from the late 80s and early 90s have also played a significant role. The production has now somewhat stabilize due to lower prices and high competition in the markets.

The European turbot is another important cultured species although produced in Atlantic coast of Spain and France. This species is cultured in intensive land-based systems. Production in 2001 was 4 338 tonnes.

Noticeable is the production of the Flathead grey mullet (*Mugil cephalus*) with 102 470 tonnes mainly from Egypt. For certain other species the production is limited as the farming activity is based on stocking of young fish from the wild (capture-based aquaculture). This is the case of the European eels (3 591 tonnes) and the Bluefin tuna (*Thunnus thynnus*). Spain and Croatia are the leading countries in this new tuna farming activities where most of the Mediterranean catch quota is used for farming (fattening) purposes. During the last 3-5 years there has been a very important development of tuna farms in the Mediterranean, now reaching about 20 farms.

CONSTRAINTS AND REQUIREMENTS FOR A SUSTAINABLE DEVELOPMENT

The importance of aquaculture has been recently recognized by the European Commission, who has recently, in October 2002, designed a strategy document (COM, 2002, 511 final) for the sustainable development of European aquaculture. This strategy is designed to strengthen the role of aquaculture in providing jobs and in supplying fisheries products in a way that does not harm the environment. The necessity of ensuring a sustainable development was already recognized in 1995 with the adoption of the FAO Code of Conduct for Responsible Fisheries (CCRF). Article 9 covers aquaculture.

A series of initiatives to implement the CCRF principles in the region have been undertaken and is a main objective of the Committee on Aquaculture of the General Fisheries Commission for the Mediterranean (CAQ-GFCM). Thus, in June 2000, the CAQ met in Rome on a Consultation on the Application of Article 9 in the region. Moreover, the GFCM Aquaculture Networks (TECAM and SELAM), which are coordinated by the International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM), consider the principles of the Code as a reference point for all their activities.

Furthermore, appropriate planning, providing regulations and incentives for developing and improving sustainable aquaculture practices, is not only an objective of states, but is being recognized by aquaculture producers (see the Code of Conduct of European Federation of Aquaculture Producers).

As in other parts of the world, the aquaculture sector in the Mediterranean is facing a series of constraints, mainly related to the evolution of markets, site availability, inputs (mainly seeds), diseases, planning, infrastructures and human resources. Mediterranean aquaculture can be divided into different sub-sectors, each at a different level of development and facing different constraints. Thus, in fish production, whilst the trout sector faces the constraint of an ageing industry, the seabass and seabream industry could be described as a sector already entering a mature phase. Competition has increased, and prices and margins have significantly diminished, demanding additional efficiency, productivity and economies of scale. This is driving industry policy in further pursuit of size, and in the development of more efficient production systems and new technologies, such as offshore aquaculture and recirculation aquaculture systems.

In this context, the constraints for the future development of the sector can be grouped into different categories, each requiring not only specific actions, but also proper coordination. The constraints that need addressing are related to:

- biological and technical aspects, mainly referring to disease problems, but also including biodiversity concerns due to the introduction of new species in the region;
- market constrains, such as fluctuation of prices, food safety, quality control problems, image of aquaculture products, etc.;
- zoo-technical constraints, such as seasonality of production, and uncompleted life-cycles for certain species (e.g., eels and tuna);
- environmental concerns, linked to the location of farms and the impact of their effluents on the surrounding environment;
- access to coastal areas, i.e. scarcity of potential sites for new aquaculture projects, and competition with other coastal users (urbanization, tourism, navigation, wildlife park projects, harbours, maritime traffic, etc.); and
- scarce administrative organization with regards to the integration of aquaculture activities in coastal areas.

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